Price 1*s.*

Geological Series
Bulletin No. 20

UNION OF SOUTH AFRICA

DEPARTMENT OF MINES

EARTHQUAKES

in

SOUTH AFRICA

by

L. J. KRIGE, M.A., PH.D., AND B. D. MAREE, M.Sc.

(Translated by the Translation Bureau from the original Afrikaans)

Publication of the Geological Survey Division

The Government Printer, Pretoria
1951

G.P.-S.8626—1950-1—1,500.

Price 1*s.*

Geological Series
Bulletin No. 20

UNION OF SOUTH AFRICA

DEPARTMENT OF MINES

EARTHQUAKES

in

SOUTH AFRICA

by

L. J. KRIGE, M.A., PH.D., AND B. D. MAREE, M.Sc.
(*Translated by the Translation Bureau from the original Afrikaans*)

Publication of the Geological Survey Division

The Government Printer, Pretoria
1951

G.P.-S.8626—1950-1—1,500.

CONTENTS

EARTHQUAKES IN SOUTH AFRICA

I.—INTRODUCTION

Interest in the occurence of earthquakes within the Union has been shown by the Geological Survey since 1933. Two reports (1) and (2) describing three earthquakes have been published by the Geological Society of South Africa. It is the purpose of the present report to direct attention to data collected in connection with eleven further earthquakes since 1938.

This information was obtained by means of questionaires sent out to magistrates, postmasters, and postal agents in areas where the effects of the various earthquakes were expected to have made themselves felt. These questionnaires, which contained a list of seventy-three questions and were printed in both official languages, were sent out at the first mention of any news in the press or elsewhere of the occurrence of an earthquake in the Union. The questions were framed on the basis of Mercalli's modified intensity scales of 1931 (3), and the intensities referred to in the text therefore correspond to those given in that scale.

The authors wish to take this opportunity to thank all those who so readily gave their services and also the two seismologists in the Union, one at the Royal Observatory, Cape Town, and the other at the Union Observatory, Johannesburg, which are situated at long. 33° 57·5′ S. and lat. 18° 27·5′ E. and at long. 26° 11·0′ S. and lat. 28° 4·5′ E. respectively. They are also indebted to the Assistant Seismologist, Department of Applied Mathematics, University of Cape Town, for copies of some of his bulletins from which information has been drawn and to the Union Astronomer, Johannesburg, for the loan of seismograms, which have provided further useful data.

The earthquakes which were investigated are dealt with in chronological order. The times given refer to South African Standard Time on the 24-hour system. No claim as to completeness is made for the account, as other earthquakes may have occcurred without their having come to the notice of the authors.

II.—THE EARTHQUAKES

A. In Zululand

This earthquake was investigated by Dr. D. J. Simpson of the Geological Survey, and the data concerning it were taken from his report on the occurence.

Intensity and epicentre

The isoseismal lines on the accompanying map were plotted on the basis of information obtained from the returned questionnaires. The most severe shocks (intensity V) were experienced at Zwart Folozi and Vetspruit, so that the epicentre must have been somewhere between these two localities and, as determined on the basis of the isoseismal lines, approximately at 27° 50′ S. and 31° 20′ E. Shocks of intensity IV were reported from an area some 100 miles across and extending from Dwaleni

in the north to Melmoth in the south. The earthquake was registered at the Union Observatory but not at the Royal Observatory. As appears from the isoseismal lines the shocks faded out more rapidly towards the east and the west than towards the north and the south. The following table contains a summary of the available reports and confirms the accuracy of the isoseismal lines:—

Zone of intensity	Number of reports on intensity				Not observed
	V	IV	III	II	
V	2	—	—	—	—
IV	—	16	9	—	3
III	1	8	18	2	16
II	—	—	—	5	20

Time and duration

At the Union Observatory, Johannesburg, a light, semidistant earthquake lasting about a minute was registered at 22 h. 04 m. on 10th February, 1938. The duration was estimated by observers at from 3 seconds to 4 minutes, with an average of about 50 seconds.

Fore-shocks and after-shocks

Possible fore-shocks were observed at Paddock at 20 h. 20 m. and during the day on the 10th February at Doringberg. It was reported from Lipofaneni and Nsoko that a tremor was experienced on 28th January, and according to reports in the newspapers an earthquake was felt between Ngutu and Barkly East on the same day as the one in Zululand, although all questionnaires forwarded to this area showed negative returns.

Damage

Walls of buildings were cracked at Zwart Folozi, and at Vetspruit there were slight cracks in walls and some pieces of glassware were broken.

Possible geological explanation

The epicentre of the 1936 earthquake in Zululand was in the vicinity of Mooihoek, which is situated close to the contact of the Pongola system and the Old granite. The epicentre of the earthquake under discussion was also in the vicinity of that contact, and the shock may possibly have originated as a result of a similar movement along the contact.

B. At Bethlehem

Intensity and epicentre

It was possible to plot an isoseismal chart showing zones of intensities V, IV, and a portion of III. The shock was most severe at Harrismith, Kestell, Bethlehem, and Daniëlsrust, all of which were within zone V. It is clear, therefore, that the epicentre must have been within the area surrounded by these four places, probably in the vicinity of Afrikaskop station and approximately at 28° 10′ S. and 28° 40′ E. Tremors of the fifth degree of intensity were experienced over an area approximately 50 miles in diameter, and zone IV was of much the same width. The intensity zones are remarkably circular and narrow, indicating that the first shock probably originated from a point and at comparatively shallow depth. The data are summarised in the following table:—

Zone of intensity	Number of reports on intensity			Not observed
	V	IV	III	
V	5	1	—	—
IV	3	8	1	13
III	—	—	1	43

As the earthquake occurred so early in the morning, it was observed by very few people and passed unobserved even in the zone of intensity IV at some places.

Time and duration

At Buthabuthe, Harrismith, and Senekal the shock was observed at 01 h. 40 m., 01 h. 43 m., and 01 h. 45 m. respectively, so that the earthquake may be stated to have originated at approximately 01 h. 40 m. on the 1st March, 1940. Its duration was estimated at from 4 seconds to 2 minutes by seventeen observers, with an average of 25 seconds.

Fore-shocks and after-shocks

Two distinct tremors were felt at Senekal at 01 h. 35 m. and 01 h. 45m., while at Harrismith an after-shock was observed at 02 h. 45 m.

Damage

Light damage to buildings was reported from Harrismith, Bethlehem, Daniëlsrust, Kestell, Petrus Steyn, and Warden. For the greater part this amounted to the cracking of walls and loosening of plaster in old buildings. at Harrismith the banks of the local spruit caved in at a few places.

Possible geological explanation

No specific indications capable of offering an explanation of an earthquake are revealed by the known geological structure of the Beaufort series around Afrikaskop, in the vicinity of which the epicentre must have been. Some faults have, however, been mapped farther south in the Karroo system, and it is therefore possible that the earthquake originated in one

or other unknown fault around Afrikaskop, such origin conforming to the isoseismal lines, which indicate a localised and near-surface focus.

C. In Mozambique

Intensity and epicentre

This earthquake differs from all the others in that it was of greater severity and had wider zones of intensity, so that it was felt over a greater area. Shocks of the fourth and fifth degrees of intensity were observed throughout the greater parts of Natal, Transvaal, Southern Rhodesia, and Mozambique. No shocks of intensity VI were reported by any observer, but there is little doubt that this intensity must have been prevalent in the major portion of Mozambique, from which, unfortunately, no reports were received. Some observers reported intensities closely approaching the sixth degree from the eastern Transvaal.

The map shows clearly that the isoseismal lines consist of arcs of circles with a common centre in the middle of Mozambique and with eastern sectors extending to well over the Mozambique channel. The earthquake must have had its epicentre at approximately 22° 30′ S. and 33° 30′ E., i.e. some 120 miles from the coast and more or less half-way between Beira and Lourenço Marques. The zone of intensity IV was approximately 150 miles in width, indicating great focal depth. On the assumption that the zones maintained the same width as the zone of intensity IV the degree of intensity at the epicentre must have been of the order of intensity VII. A summary of the data is given in the following table:—

Zone of intensity	Number of reports on intensity			Not observed
	V	IV	III	
V	42	8	—	3
IV	8	40	8	47
III	—	1	6	49

Time and duration

The shock was registered at 20 h. 18 m. on the 19th May, 1940 at the Union Observatory in Johannesburg, four observers recording the time of the occurrence as 20 h. 20 m., one at Messina as 20 h. 15 m., and another at Salisbury as 20 h. 30 m. Ninety-one observers estimated the duration of the shocks at between 3 seconds and 15 minutes, giving an average duration of 2 minutes. The seismograph in Johannesburg showed heavy vibrations for the space of a minute, although the various phases affected the instrument for a period of 15 minutes.

Fore-shocks and after-shocks

Four observers reported two separate shocks following on each other at an interval of between 1 and 3 minutes, but these probably represented the two main phases of a single shock, which is apparently all that occurred.

Direction of propagation

Numerous reports regarding the direction in which the shock was apparently propagated were received from observers. Five from Rhodesia reported the shock as having arrived from the east, two as from the south-east, and two as from the south. As against these nine directions, which are in agreement with the position of the epicentre, four observers recorded opposite directions. Of the reports from within the Union eight were in agreement with the position of the epicentre and four not. The observers therefore reported seventeen directions that tallied as against eight that were not in keeping with the facts.

Damage

Only slight damage such as cracked walls, steps, paths, and plaster was reported from various localities in the eastern Transvaal. At Pilgrim's Rest the church was reported as having been shaken so severely that the congregation became alarmed and the service had to be suspended.

Possible geological explanation

The widths of the intensity zones prove that the earthquake must have originated at depth, and no indications of its cause can therefore be expected from the surface geology. However, it is possible that deep-seated movements related to the Lebombo monoclinal flexure and associated folding and faulting may have been responsible.

Seismographic data

In the bulletin issued by the Assitant Seismologist in Cape Town the earthquake was reported as follows:—

Record No. 950, 19th May, 1940.

Phase	N.–S. component			E.–W. component		
	hour	minute	second	hour	minute	second
iP.....	20	20	34	20	20	32
iS.....	20	23	22	20	23	20
i.....	20	25	18	20	25	18
i.....	20	26	28	20	26	32
F.....	21	50	—	21	50	—

Near shock, $d = 14{\cdot}3°$, $H = 20$ h. 17 m. 08 s.

The seismogram of the Union Observatory, Johannesburg, was analysed as follows:—

Date: 19th May, 1940.

Phase	N.–S. component			E.–W. component		
	hour	minute	second	hour	minute	second
P.....	20	17	51	20	17	51
S.....	20	18	57	20	19	00
	20	22	15	20	22	03
	20	25	30	20	25	24

The time of the origin of the earthquake at the focus is denoted by *H*. The distance between the epicentre and the observation station is expressed in degrees of the earth's curvature and is denoted by *d*. *H* and *d* are calculated from the times of arrival of the primary (*P*) and the secondary (*S*) waves, and for the purposes of this report the "Travel-time Tables for Earthquakes of Normal Focal Depth" compiled by Jeffreys and Bullen and as quoted by Leet (4) in table XVI, page 170, have been used. On the basis of the positions of the epicentre and of the seismographic stations as indicated above it is calculated that the distance of the epicentre was 5·9° or 410 miles from Johannesburg and 17·1° or 1,180 miles from Cape Town. If the first two phases registered by each of the seismographs are taken as *P* and *S*, then according to the tables $d=5\cdot9°=410$ miles and $H=20$ h. 16 m. 28 s. in the case of the Johannesburg recording and $d=15\cdot2°=1{,}050$ miles and $H=20$ h. 17 m. 01 s. for the Cape Town recording. If *d* is taken as being equal to 17·1°, as obtained on the basis of the positions, and used with the Cape Town recording, then $H=20$ h. 16 m. 38 s., which agrees more closely with the result obtained from Johannesburg recording. The first phase arrived 162 seconds later at Cape Town than at Johannesburg. This retardation according to the tables represents a difference in distance of 11·5° and compares very well with the difference of $17\cdot1°-5\cdot9°=11\cdot2°$ obtained from the position of the epicentre.

All the above deductions and comparisons prove that even though the tables are not capable of detailed application the earthquake may nevertheless be regarded as being of normal focal depth and that conditions comparable to those in other parts of the world obtained.

D. At Aberdeen

At 15 h. 45 m. on the 13th October, 1940 Aberdeen was shaken by an earthquake of intensity V. A positive report regarding the occurrence was received from only one other place, i.e. Kendrew station some 25 miles to the east of Aberdeen, where the intensity was of the third degree. This earthquake obviously was of an extremely localised nature and had its epicentre in the vicinity of Aberdeen, at approximately 32° 30′ S. and 24° 00′ E. From the fact that the intensity showed a decrease of 2 degrees over a distance of no more than 25 miles it would appear that the focus was at shallow depth and the affected area of limited extent.

E. At Tzaneen

Intensity and epicentre

Shocks of intensity VI were reported from Tzaneen, Leydsdorp, Gravelotte, and Chuniespoort. The epicentre must therefore have been within the area surrounded by these places, at about 24° 00′ S. and 30° 10′ E. Shocks of intensity V were felt over an area some 120 miles across, and the zone of intensity IV was about 80 miles wide. A summary of the data appears in the following table:—

Zone of intensity	Number of reports on intensity				Not observed
	VI	V	IV	III	
VI	3	1	—	—	—
V	1	10	1	1	4
IV	—	4	10	2	34
III	—	—	—	—	—

Time and duration

The time at which the shock occurred was reported by three observers as 23 h. 00 m., 23 h. 40 m., and 23 h. 53 m. on the 10th November, 1940. The duration of the shock was estimated at between 2 seconds and 5 minutes by twenty-six observers, with an average of 80 seconds. No report regarding the earthquake was received from the seismological stations.

Damage

Walls of old buildings were cracked at Tzaneen, Chuniespoort, and Munnik; only plaster was damaged at Leydsdorp and Huntleigh.

Possible geological explanation

Possible explanations that may be advanced are isostatic adjustment below the Drakensberg or movement along the contact of the Old granite or Swaziland system and the Black Reef beds. The last-mentioned form the Drakensberg escarpment, and the epicentre was at the foot of this escarpment.

F. In Namaqualand

At about 20 h. 30 m. on the 23rd October, 1941 an earthquake occurred, exceptionally enough, along the west coast of the Union; it was of intensity V. According to the isoseismal lines it must have had its epicentre at a point along the coast due west of Bitterfontein station, at approximately 31° S. and 17° 40′ E. The semicircle on dryland where shocks of intensity V were experienced had a radius of about 60 miles,

and over a belt some 70 miles in width around this shocks of intensity IV were felt. A report of shocks of intensity III was received from Pella on the Orange river. The eleven localities from which shocks of intensity V were reported are all included within the isoseismal line of that order. Reports of shocks of intensity IV were received from four localities falling between these two lines, and no shocks were observed at eleven stations.

According to the observers the shocks lasted from 5 seconds to 3 minutes, with an average of 70 seconds, and caused no damage. Nine out of eleven observers reported the shock as ariving from the west, and this supports the location of the epicentre along the coast. There was no seismographic report.

In the area of the probable epicentre several post-Transvaal and also possibly post-Cape faults are known that may explain the occurrence of an earthquake in this region. Geologically it may be of interest to note the possibility of these faults being either still active or rejuvenated.

G. At Port Shepstone

Intensity and epicentre

This was the severest earthquake experienced in the Union since 1936. Shocks of intensity VI were felt over a large area, and the shock approximated the seventh degree at Port Shepstone and Munster. The area in which tremors of intensity VI occurred had a radius of 70 miles, and each of the zones of intensities V, IV, and III, which it was also possible to determine, was some 50 miles wide. As these zones are comparatively narrow, a fairly near-surface focus is indicated. The earthquake had its epicentre in the ocean somewhere opposite Munster, at approximately 31° 10′ S. and 30° 30′ E. A summary of the observations for each zone appears in the following table:—

Zone of intensity	Number of reports on intensity					Not observed
	VI	V	IV	III	II	
VI.....	11	3	—	—	—	—
V.....	—	21	4	—	—	—
IV.....	—	2	13	1	—	11
III.....	—	1	1	4	—	24
II.....	—	—	—	—	4	25

Time and duration

The main shock was observed at about 06 h. 50 m. on the 1st November, 1942 but was preceded and followed by other shocks, the first of which was reported as having occurred at 01 h. 00 m. and the last at 21 h. 45 m. The main shock was estimated by the observers as having lasted from 2 seconds to 3 minutes, with an average of 30 seconds. At the Union Observatory a shock lasting 70 seconds was registered at 06 h. 08 m. 21 s. followed by a more severe shock of 3½ minutes' duration at 06 h. 51 m. 33 s.

Direction of propagation

Thirteen out of the eighteen reports on the direction in which the waves travelled were in agreement with the suggested position of the epicentre.

Fore-shocks and after-shocks

Four distinctly separate shocks were distinguished at Harding, Port St. Johns, Port Shepstone, and Umzinto, and two to three were reported from several other localities. The first fore-shock was reported at 01 h. 00 m. from Camperdown, and the last after-shock for that day was observed at Glenmore at 21 h. 45 m. At 13 h. 30 m. on the 4th November a shock was observed at Harding and another at Barkly East at 15 h. 00 m. The seismograph in Johannesburg registered only two shocks. The maximum movement of the needle caused by the fore-shock was 0·1 cm. in contrast to 1·9 cm. for the main shock. This fore-shock was reported by nineteen observers and was the most severe of all the fore-shocks. An analysis of the available data appears in the following table:—

Shock	Time: 1st November, 1942	Duration in seconds	Locality	Intensity
a	01·00	5	Camperdown	III
	01·30	—	Port St. Johns	IV
b	05·00	—	Elliotdale	—
c	05·40	—	Elliotdale	—
	05·55	—	Lusikisiki	—
	06·00	—	Engcobo	—
	06·00	30	Holy Cross Mission, East Pondoland	III
	06·00	—	Kokstad	—
	06·00	—	Umkimkulu	—
	06·00	—	Bizana	—
	06·00	—	Umzinto	—
	06·00	5	Ixopo	IV
	06·00	—	Glenmore	—
	06·05	—	Franklin, Port Shepstone, Flagstaff	—
	06·07	2	Himeville	IV
	06·08	—	Port St. Johns	—
	06·08	30	Johannesburg	—
	06·10	—	Harding	—
	06·10	—	Mtunzini	—
	06·10	15	Mount Ayliff	III
	06·15	3	Libode	—
d	06·20	2	Ngweleni	—
	06·20	—	Flagstaff	—
	06·30	—	Port St. Johns	—
	06·30	—	New Hanover	—
	06·35	—	Port Shepstone	—
	06·40	—	Harding	—
e	Main shock reported by sixty-five observers at times between 06 h. 45 m. and 07 h. 30 m.			VI
f	20·00	—	Port Shepstone	III
g	21·45	—	Glenmore	—

From the above table it appears that there were at least four fore-shocks and two after-shocks, none of which probably was of higher intensity than the fourth degree.

Damage

Walls were cracked in Port Shepstone, and plaster from old as well as new buildings was damaged; a chimney collapsed, and rocks rolled from krantzes in the mountains. Rock falls and small groundslides were also reported from Munster. Damage was done to walls and plaster at Rhodes, Port St. Johns, Flagstaff, Ixopo, Glenmore, Himeville, Umzinto, Thabankulu, Bizana, and Willowvale. At Flagstaff a wall was noticed to have been moved about half an inch. Steps were cracked at Margate, and glassware was broken at Glenmore. In Durban the electric stove and the refrigerator of one observer were reported to have been put out of action.

Possible geological explanation

There are numerous faults of Cretaceous age present in the country around Port Shepstone, and it is possible that some of these may still be active and may have been the cause of the shocks.

Analysis of seismograms

The only seismograms available are those of the Union Observatory, and these have been analysed as follows:—

Date: 1st November, 1942.

Phase	N.–S. component			E.–W. component		
	hour	minute	second	hour	minute	second
Fore-shock—						
P.....	06	08	21	06	08	21
Main shock—						
P.....	06	51	33	06	51	33
S.....	06	52	36	06	52	39
	06	53	57	06	54	00

If the first two phases of the main shock are taken as *P* and *S*, then $d = 5 \cdot 6^\circ = 385$ miles and $H =$ 06 h. 50 m. 15 s. According to the isoseismal lines $d = 5 \cdot 4^\circ = 370$ miles, which agrees very closely with the value deduced from the seismogram.

H. At Prieska

Prieska and the surrounding country experienced an earthquake of limited extent and intensity V at 20 h. 45 m. on the 24th November, 1943. The most severe tremors were observed along the Doringberg, which extends in a northwesterly direction from Sodium station towards the Orange river. Shocks of intensity V were felt at Sodium, Omdraaisvlei, and Prieskaspoort. The shocks rapidly diminished in intensity, so that at

a distance of 10 miles from the mountains shocks of intensity IV and 30 miles away shocks of intensity III were reported. From the oval shape of the isoseismal lines the shocks would appear to have originated from more than one point or along a line.

A characteristic feature of this earthquake was that apparently the shock was propagated through the air rather than through the earth, as observers reported a loud rumble in the air "as if an express train was thundering across the mountains" and this noise was heard at greater distances than those at which the shocks were observed. The rumble as well as the narrow zones of intensity indicate a near-surface focus. The centre of the closed line falls at a point some 25 miles southeast of Prieska, at approximately 30° S. and 23° E., which is more or less the position of the epicentre.

Shocks of intensities V, IV, and III were reported from four, six, and three localities respectively.

Plaster was damaged in one old building at Prieska, but beyond this no damage was reported.

Possible geological explanation

As shown in the map accompanying this volume a post-Transvaal fault runs parallel to the Doringberg and cuts through the central part of the intensity zones. Three of the localities from which shocks of the fifth degree of intensity were reported are situated approximately on this fault; it would appear, therefore, that the earthquake originated from a displacement along this fault. This would explain, too, the oval shape of the isoseismal lines, with the major axis parallel to the Doringberg and the fault. This ancient fault either may still be active or may have been rejuvenated.

I. At Beaufort West

This earthquake was felt at Beaufort West during the night of the 28th August, 1944. In six questionnaires returned from neighbouring localities it was reported that no shock had been observed. At Beaufort West the shocks attained intensity III and lasted for only a few seconds. If the tremor indeed resulted from an earthquake, it must have had its epicentre very near to Beaufort West, in the vicinity of 32° 30′ S. and 22° 30′ E., and must have been in the nature of a localised shock, as it went unobserved at places no more than 30 miles away. The fact that no further reports were obtained is easily understood, as the area is very thinly populated and the nearest point to which questionnaires were sent is 30 miles from Beaufort West and there the shock may have attained intensity II only and may thus have passed unnoticed.

J. At Vryheid

The earthquake attained intensity V at Vryheid only, so that it must have had its epicentre close to that town, at approximately 27° 40′ S. and 30° 50′ E. Shocks of intensity IV were reported from Zuinguin and Hlobane, intensity III from Gluckstadt, Mount Ngwibi, and Paulpietersburg, and at five localities within zone of intensity III no shocks were observed. Shocks of the second degree were noticed only at Melmoth,

and no shocks at all were observed at ten localities around zone III. As these shocks were observed at no more than seven localities, the isoseismal lines could be plotted only approximately.

The shock was felt at about 22 h. 15 m. on the 17th September, 1944 and lasted about 10 seconds. The observer at Hlobane reported that he had also noticed a tremor during the previous evening at about 22 h. 00 m.

Walls and window-panes were cracked at Vryheid, but no further damage was reported.

The earthquake originated in an area containing several collieries. Numerous small faults are shown on the geological map of this area, and it is possible that movement along an old fault may have given rise to the shock. The epicentre was, however, also in the neighbourhood of the Lebombo monocline, so that the shock may also have been associated with readjustment of the post-Cretaceous disturbances.

K. At Ladybrand

An earthquake was experienced at 12 h. 55 m. on the 12th November, 1944 in the country around Ladybrand, Clocolan, Ficksburg, and Maseru. Shocks attaining intensity V were reported from Ladybrand, Modderpoort, Gumtree, and Teyateyaneng. Zone V is about 40 miles in width and zone IV, which it was possible to determine only approximately, about 30 miles. The isoseismal lines are circular, with the epicentre situated approximately on the Basutoland border half-way between Ladybrand and Ficksburg, at about 29° S. and 27° 40′ E. The reports received included five of shocks attaining intensity V, twelve of intensity IV, one of intensity III, one of intensity II, and twenty-seven that were negative, making a total of forty-six returns. The fact that the earthquake occurred about midnight is responsible for the small number of returns rendered, thus making it impossible to determine the zones of lower intensity.

The average duration was approximately 30 seconds. The direction of progagation as reported by twelve observers was in no single instance in agreement with the position of the epicentre; this abnormal disparity may have been due to the observations having been made late at night. Reports of damage were received only from Teyateyaneng in Basutoland, where window-panes and glassware were broken.

Apart from the fact that the epicentre was situated at the foot of the Drakensberg there is no known geological occurrence to which the cause of the earthquake may be ascribed.

III.—GENERAL SUMMARY

From this method of investigation earthquakes results are obtained that may be of use in the study of the seismological condition and the geology of the country. The information returned on the questionnaires frequently proved fairly accurate, making it possible to correlate the deduced situation of the epicentre and the width of the intensity zones with the geology of the country. In some cases intensities were arrived at that were not in conformity with those for the particular locality, but but this may be due to the personal factor as far as the observer is concerned or to local conditions. The lower zones of intensity are difficult to determine, as observation of these depends largely on local conditions and on the time of day. A shock could, for example, easily pass unnoticed late at night or during very busy hours or in a very busy locality. It is our opinion that the positions of the epicentres have been determined correctly to within 10 minutes and the widths of the zones to within 25 miles. It is to be regretted that more seismographic data are not available. If a more complete study is to be made, several more seismographs will be required in the country, as doubtless many earthquakes pass unobserved.

The fourteen earthquakes investigated by the Geological Survey since 1932 are distributed throughout the Union. The eastern half would, however, appear to be more liable to the occurrence of earthquakes, although this impression may arise from the fact that this part, in contrast to the western half, is more thickly populated and consequently better equipped for the reporting of news. It is clear, therefore, that the whole of the Union is slightly unstable, but the shocks that occur are fortunately not of such severity as to cause much damage or to threaten life and limb. The greatest intensity attained during the past twelve years was that of the sixth degree, which is characterised by the following: people are wakened from their sleep, become frightened, and walk staggeringly; church-bells are set ringing, and furniture is shifted; light to fairly heavy damage is caused to poorly constructed buildings; glassware and window-panes are broken.

It was possible for some of the earthquakes to be correlated with known geological occurrences, although most are probably related to movements affecting the entire subcontinent, which since the Cretaceous has constantly been subject to relative elevation or depression to which our juvenile topography must be ascribed ([5]). The areas with comparatively recent geological features are also those that are most liable to earthquakes and that have experienced the highest intensities.

BIBLIOGRAPHY

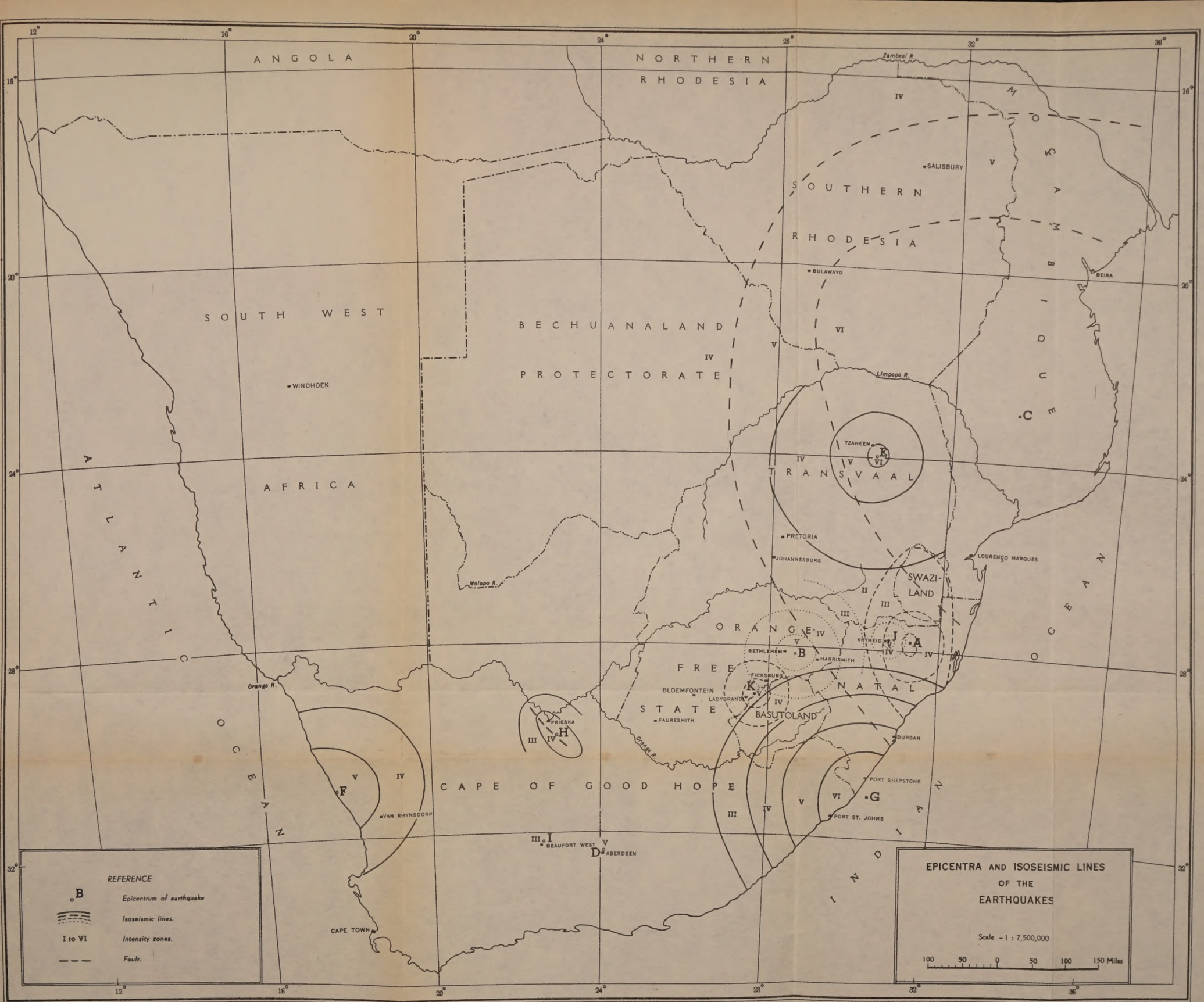
1. KRIGE, L. J. and VENTER, F. A. "The Zululand Earthquake of the 31st December, 1932." *Trans. geol. Soc. S. Afr., XXXVI*, 1933, *pp.* 101–112.

2. KRIGE, L. J. ..... "The Swaziland and Fauresmith Earthquakes of January 1936." *Trans. geol. Soc. S. Afr., XXXIX*, 1936, *pp.* 429–440.

3. WOOD, H. O. and NEUMANN, F. "Modified Mercalli Intensity Scale of 1931." *Bull. seism. Soc. Amer.*, 21, 4, 1931, *pp.* 277–283.

4. LEET, L. D. ..... "Practical Seismology and Seismic Prospecting." *Appleton - Century, New York*, 1938, *pp.* 430.

5. KING, L. C. ..... "South African Scenery." *Oliver and Boyd, Edinburgh*, 1942, *pp.* 340.



Printed in the Union of South Africa by the Government Printer, Pretoria

Drawn in the Geological Survey Office, Pretoria